CLAIMS

WHAT IS CLAIMED IS:

1. An integrated interferometric microscopic inspection system for inspecting semiconductor wafers, the system comprising:

an illumination module configured to generate a first illumination beam for interferometric inspection in a first mode and a second illumination beam for intensity based microscopic inspection in a second mode;

an integrated interferometric microscope module configured for both inteferometric and intensity based microscopic inspection, in the interferometric inspection mode for splitting the first illumination beam into a test beam directed to the semiconductor wafer and a reference beam towards a reference mirror, and combining the test beam reflected from the wafer and the reference beam reflected from the reference mirror to form an interference image and to reflect the second illumination beam from the wafer; and

at least one image sensor configured to receive the interference image and the reflected second illumination beam from the integrated interferometric microscope module.

2. The inspection system of claim 1, further comprising a processing module configured to generate complex field information corresponding to the semiconductor wafer from the interference image signal.

3. The inspection system of claim 2, wherein the processing module is further configured to generate a microscope inspection signal corresponding to the intensity of the reflected second illumination beam.

4. The inspection system of claim 1, wherein the reference mirror is tilted with respect to the incident reference beam to generate fringes in the interference image.

5. The inspection system of claim 1, wherein the illumination module is configured to switch between the first illumination beam and the second illumination beam.

6. The inspection system of claim 1, further comprising a shutter to isolate the reference mirror from the optical path of the reference beam.

7. The inspection system of claim 1, wherein the image sensor is configured in a frame capture mode to acquire inspection signals for phase based inspections using a spatial fringe analysis technique.

8. The inspection system of claim 1, wherein the image sensor is configured in a time delay integration mode to acquire inspection signals for phase based inspection using a spatial fringe analysis technique.

9. The inspection system of claim 8, wherein the image sensor is configured in a frame capture mode for phase based inspection and time delay integration mode for intensity based inspection.

10. The inspection system of claim 8, further comprising an adjustment mechanism configured to adjust the reference mirror along the axis of the reference beam incident upon the reference mirror to maintain the positioning of the spatial fringe lines on the sensor relative to structures in the image on the sensor.

11. The inspection system of claim 1, further comprising a switching mechanism for switching the operation of the inspection system between interferometric measurement and microscopic measurement.

12. The inspection system of claim 1, wherein the switching mechanism comprises a switchable shutter located in the incident reference beam path to the reference mirror and a switchable illumination source.

13. The inspection system of claim 8, further comprising a stage to provide movement of the semiconductor wafer in at least one direction, and wherein the spatial fringes are aligned with the direction of movement of the stage.

14. A method for inspecting a wafer using interferometric and intensity based microscopic techniques, the method comprising:

combining a test wave reflected from a first portion of a wafer and a reference wave reflected from a reference mirror to produce on an image sensor an interference optical image;

reconstructing complex field information for the first portion from the interference optical image;

generating a first signal representation of the first portion of the wafer using reconstructed complex field information;

measuring the intensity of a test wave reflected from a second portion of the wafer using microscopic techniques to generate a third signal representation; and

comparing the first signal representation and the third signal representation to a second signal representation of a wafer to generate a resultant signal representation, wherein the resultant signal representation is used to identify defects in the first portion of the wafer.

15. The method for inspecting a wafer recited in claim 14, wherein the second signal representation corresponds to a design database file.

16. The method for inspecting a wafer recited in claim 14, wherein the image sensor is configured in a frame capture mode to acquire measurement signals for phase based measurements using a spatial fringe analysis technique.

17. The method for inspecting a wafer recited in claim 14, wherein the image sensor is configured in a time delay intregration mode for phase based measurement and wherein the phase based measurement analyzes spatial fringes formed on the sensor.

18. The method for inspecting a wafer recited in claim 14, wherein an adjustment mechanism is configured to adjust the reference mirror along the axis of the reference beam incident upon the reference mirror to maintain the positioning of the spatial fringe lines on the sensor relative to structures in the image on the sensor.

19. The method for inspecting a wafer recited in claim 14, wherein the maintenance of the positioning of the spatial fringe lines occurs in response to movement of the semiconductor wafer by a stage.

20. A method for performing interferometric inspection comprising:

directing an illumination beam through an interferometric microscope to a semiconductor wafer, the illumination beam being split into a test beam and a reference beam in the interferometric microscope; and

combining the reference beam reflected from a reference mirror and the test beam reflected from the wafer to generate an interference image having spatial fringes on a time delay integration mode sensor.

21. The method for performing interferometric inspection as recited in claim 20, further comprising moving a stage supporting the wafer and synchronizing the movement of the stage with the movement of the interference image on the sensor.

22. The method for performing interferometric inspection as recited in claim 21, wherein synchronizing the movement of the stage with the movement of the interference image comprises controlling the movement of the interference image relative to the sensor by adjusting the movement of the reference mirror in the direction of the axis of the reference beam incident upon the reference mirror.

23. The method for performing interferometric inspection as recited in claim 22, wherein the movement of the reference mirror is adjusted to maintain, as the wafer is moved by the stage, a constant optical path difference between the test beam and the reference beam for a selected portion of the interference image pertaining to a corresponding portion of the wafer.

24. The method for performing interferometric inspection as recited in claim 20, further comprising moving a stage supporting the wafer to induce movement of the interference image relative to the sensor, wherein the spatial fringes are oriented on the sensor so that the spatial fringe lines are aligned in the direction of the induced movement.

25. The method for performing interferometric inspection as recited in claim 20, wherein the image sensor is configured in a time domain integrated mode for both phase based and intensity based measurement.

26. An interferometric inspection apparatus comprising:

an illumination module configured to generate a first illumination beam for interferometric inspection ;

an interferometric microscope configured to split the illumination beam into a test beam and a reference beam respectively directed to and reflected from a wafer and a reference mirror and to combine the test and reference beams into an interference image having spatial fringe patterns; and

at least one time delay integration mode sensor configured to receive the interference image.

27. The interferometric inspection apparatus as recited in claim 26, further comprising a movable stage to support the wafer and wherein the apparatus is configured to control the movement of the interference image relative to the sensor by adjusting the movement of the reference mirror in the direction of the axis of the reference beam incident upon the reference mirror.

28. The interferometric inspection apparatus as recited in claim 26, further comprising a movable stage to support the wafer and wherein the apparatus is configured to synchronize the movement of the stage with the movement of the interference image on the sensor.

29. The interferometric inspection apparatus as recited in claim 26, further comprising a movable stage to support the wafer and to induce movement of the interference image relative to the sensor, wherein the spatial fringes are oriented on the sensor so that the spatial fringe lines are aligned in the direction of the induced movement.

30. An interferometric inspection system for inspecting semiconductor wafers, the system comprising:

an interferometric microscope module configured for splitting the illumination beam into a test beam directed to the semiconductor wafer and a reference beam towards a reference mirror, and combining into a combined beam the test beam reflected from the wafer and the reference beam reflected from the reference mirror, the combined beam forming an interference image, wherein the reference mirror is

configured to be adjustably tilted with respect to the incident reference beam to generate fringes in the interference image having an orientation different from a direction of a pattern on the wafer; and

an image sensor configured to receive the interference image and to generate a signal for deriving phase information..

31. The interferometric inspection system as recited in claim 30, wherein the pattern on the wafer is a repeating pattern having a dominant direction and the orientation of the fringes relative to the dominant direction is optimized.

32. The interferometric inspection system as recited in claim 31, wherein the repeating pattern has two dominant directions which are orthogonal to each other and the orientation of the fringes is adjusted to about a 45 degree angle relative to one of two orthogonal directions of the repeating pattern.

33. A method for performing interferometric inspection comprising:

directing an illumination beam to an interferometric microscope, the illumination beam being split into a test beam and a reference beam in the interferometric microscope, the test beam being reflected from a semiconductor wafer and the reference beam reflected from a reference mirror; and

combining the reference beam reflected from a reference mirror and the test beam reflected from the wafer to generate an interference image having spatial fringes on a time delay integration mode sensor, wherein the reference mirror is adjusted with respect to the incident reference beam to generate fringes in the interference image having an orientation different from a direction of a pattern on the wafer.

34. The method for performing interferometric inspection as recited in claim 33, wherein the pattern on the wafer is a repeating pattern having a dominant direction and the orientation of the fringes relative to the dominant direction is optimized.

35. The method for performing interferometric inspection as recited in claim 33, wherein the repeating pattern has two dominant directions which are orthogonal

to each other and the orientation of the fringes is adjusted to about a 45 degree angle relative to one of two orthogonal directions of the repeating pattern.

36. An interferometric inspection system for inspecting semiconductor wafers, the system comprising:

an illumination module having at least one illumination source configured to generate a first illumination beam for at least one of interferometric and intensity based microscopic inspection and a second illumination beam for intensity based microscopic inspection;

an integrated interferometric module configured for performing simultaneously at least one of a) inteferometric and intensity based microscopic inspection using the first illumination beam, and b) intensity based microscopic inspection using the second illumination beam, wherein the second illumination beam has a different frequency spectrum than the first illumination beam;

a first image sensor configured for receiving one of a first microscopic image and an interference image having spatial fringes as based on the first illumination beam; and

a second image sensor configured for receiving from the integrated interferometric microscope module a second microscopic image as based on the second illumination beam, the second microscopic image being formed simultaneously with formation of one of a first microscopic image and an interference image on the first image sensor.

37. The interferometric inspection system as recited in claim 36, wherein the an integrated interferometric module is configured for interferometric inspection by splitting the first illumination beam into a test beam directed to the semiconductor wafer and a reference beam towards a reference mirror, and combining into a combined beam the test beam reflected from the wafer and the reference beam reflected from the reference mirror, the combined beam forming an interference image having fringes generated, and for microscopic inspection by reflecting the first or second illumination beam from the wafer and directing the reflected beam onto at least one of the first and second sensors.

38. The interferometric inspection system as recited in claim 36, wherein the first illumination beam is generated by a laser source and the second illumination beam is generated by a broadband source.

39. The interferometric inspection system as recited in claim 36, wherein the first illumination beam is a narrowband beam and the second illumination beam is generated by a broadband source.

40. The interferometric inspection system as recited in claim 36, wherein the first image sensor is configured for receiving an interference image having spatial fringes as based on the first illumination beam and the first illumination beam is a laser.

41. The interferometric inspection system as recited in claim 36, wherein the first image sensor is configured in time delay integrated (TDI) mode for receiving a microscopic image as based on at least one of the first and second illumination beams.

42. The interferometric inspection system as recited in claim 36, wherein the first and second illumination beams are brightfield beams.

43. The interferometric inspection system as recited in claim 42, the first and second illumination beams are broadband beams.

44. The interferometric inspection system as recited in claim 41, wherein the interferometric sytem is configured to switch off the interferometric inspection mode by the use of a shutter.

45. A method of inspection using a combined interferometric and microscopic system comprising:

generating simultaneously a first illumination beam for at least one of interferometric and intensity based microscopic inspection and a second illumination beam for intensity based microscopic inspection towards an integrated interferometric microscope module;

forming on a first image sensor one of a first microscopic image and an interference image having spatial fringes as based on the first illumination beam; and

forming on a second image sensor a second microscopic image as based on the second illumination beam, wherein the second microscopic image is formed simultaneously with formation of one of a first microscopic image and an interference image on the first image sensor.

46. The method of inspection as recited in claim 45, wherein the first illumination beam is generated by a laser source and the second illumination beam is generated by a broadband source.

47. The method of inspection as recited in claim 45, wherein the first illumination beam is a narrowband beam and the second illumination beam is generated by a broadband source.